Quantum systems containing $S = 1$ moments which exhibit a Bose-Einstein condensation (BEC) of magnons rely on a gap between the singlet ground-state and the excited triplet state which is closed by applied magnetic field; exchange interactions broaden the gap-closing transition to a region of XY long-range order, stable between a lower critical field $B_{c1}$ and an upper critical field $B_{c2}$, above which a triplet ground state is stabilised. The compound NiCl$_2$·4SC(NH$_2$)$_2$ [1] is a $S = 1$ chain system exhibiting this effect [2]. Its low value of $B_{c1} = 2.1$ T makes it accessible to study using $\mu$SR. Moreover, unlike other BEC systems (e.g. TlCuCl$_3$), this material has a strong single-axis anisotropy with rotational symmetry in the $ab$ plane which allows conservation of magnons. We have used high-transverse field $\mu$SR to study single crystals of NiCl$_2$·4SC(NH$_2$)$_2$ with applied fields parallel and perpendicular to the $c$-axis up to 3 T at temperatures down to 15 mK. Our results allow us to characterize the phase diagram of this system on the basis of a local measurement of the spin structure and dynamics.